Common Building Block Platform

Design and Integration Guide

September 2005

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Revision History

Rev. No.	Description	Date
1.0	Initial release	September 2005

1 Introduction

1.1 Scope

The mobile computing market segment is growing at an exciting pace. In order to sustain this growth and momentum, the mobility ecosystem must be enabled to ensure the availability of ingredients for laptop computers. In addition, there is a misperception that laptop systems are highly complex, with customized system ingredients for each particular system stock keeping unit (SKU). Inflexible choice and supply fragmentation among the mobile system ingredients creates a challenge in the mobile market segment, leading to design uncertainty, inventory management complexity and integration risk. Intel is collaborating with key industry players from original equipment manufacturers (OEMs), original design manufacturers (ODMs), to address these issues.

This document provides the platform design and integration guidelines and recommendations for Intel laptop platforms using Common Building Block (CBB) compliant ingredients beginning in 2006. The CBB program was established to enable and accelerate the growth and innovation in the mobile laptop ecosystem by building upon a foundation of ingredients that comply to pre-existing industry specifications. These specifications define the mechanical form and fit and basic electrical connections of ingredients in a mobile system. Innovation, value-add, and differentiation are left to the suppliers and system designers. Intel is working together with key industry players from OEMs, ODMs, and notebook system ingredient suppliers to ensure CBB ingredients are available for integration into BB systems. The system ingredients that are currently part of the CBB program and described in this document are Hard Disk Drives (HDD), Optical Disk Drives (ODD), and Liquid Crystal Display (LCD) panels. This document does not discuss the performance, reliability, or quality of CBB ingredients.

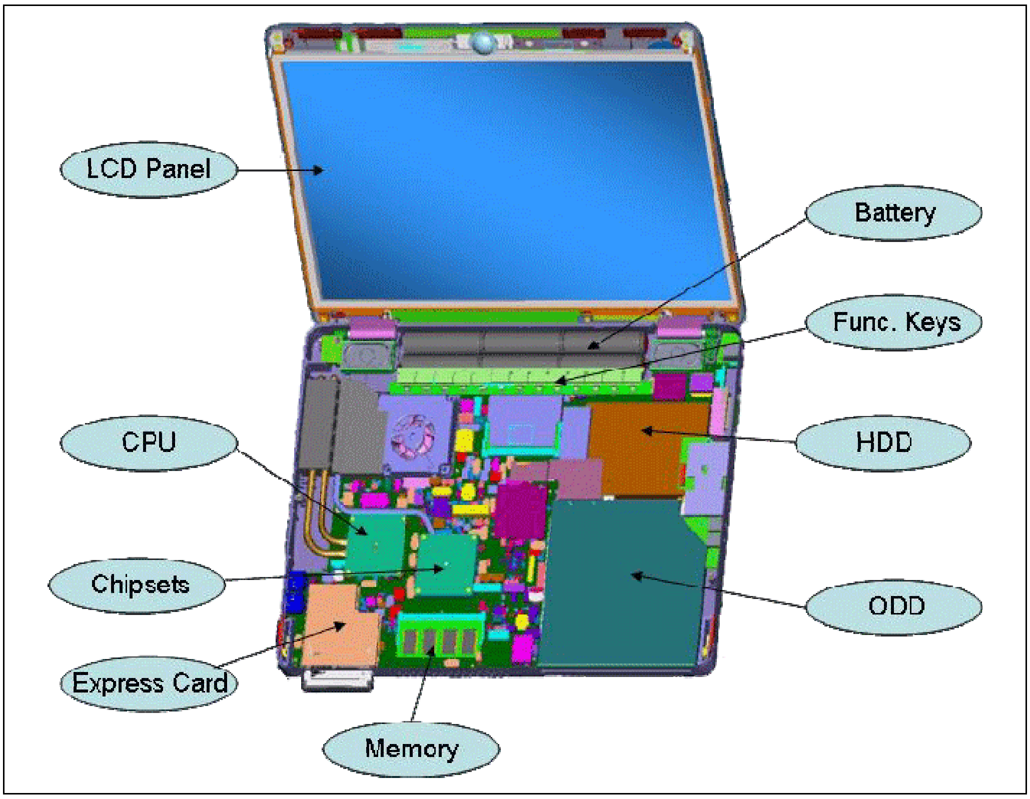
The intended audiences for this guide are laptop system designers (i.e., original design manufacturers) and integrators (channel service providers, distributors).

Figure 1 shows a typical laptop system and some of the primary system ingredients that make up a mobile platform. There are differences and design trade-offs when considering a laptop system designed for high volume manufacturing versus the design of a build-to-order (BTO) system. A laptop system designed for high volume manufacturing is a complete system that is ready for the end-user/consumer to use. On the other hand, a typical BTO laptop system, also known as a bare-bone (BB) system, often ships with the motherboard, LCD panel, chassis, and sometimes the ODD. These differences and design trade-offs are discussed throughout the document.

Section 2 provides the system design requirements and recommendations for designing laptop systems using CBB ingredients. The focus is to reduce design uncertainty by providing ODM system designers with a clear message on industry specifications and CBB requirements.

Section 3 is intended for system integrators and notebook service providers. This section provides recommendations on the system integration of each CBB ingredient.

Figure 1. Laptop System Ingredients



1.2 Terminology

Term	Description
AHCI	Advanced Host Controller Interface
ATA	Advanced Technology Attachment
BB	Bare Bones
Black Level	The lit room brightness of a display in the off state.
BTO	Build to Order
CBB	Common Building Block
CCFL	Cold Cathode Fluorescent Lamp
CIE	Commission Internationale d'Eclairage
CRB	Customer Reference Board
EDID	Enhanced Display Identification Data
ESD	Electrostatic Discharge
GBAS	Generic Bezel Attach Specification
GBPS	Gigabit per Second
HDD	Hard Disk Drive
ID	Industrial Design
IMSM	Intel Matrix Storage Manager
IMST	Intel Matrix Storage Technology
LCD	Liquid Crystal Display
LPM	Link Power Management
LVDS	Low Voltage Differential Signaling
NCQ	Native Command Queuing
ODD	Optical Disk Drive
ODM	Original Design Manufacturer
OEM	Original Equipment Manufacturer
OS	Operating System
PATA	Parallel ATA
QXGA	Quad XGA 2048 X 1536 Resolution
RGB	Red Green Blue
SATA	Serial ATA
SATA-IO	Serial ATA International Organization
SFF	Small Form Factor
SKU	Stock Keeping Unit
SPWG	Standard Panels Working Group
SXGA+	Super XGA+ 1400 X 1050 Resolution
UXGA	Ultra XGA 1600 X 1200 Resolution
WSXGA+	Wide SXGA+ 1680 X 1050 Resolution
WUXGA	Wide UXGA 1920 X 1200 Resolution
WXGA+	Wide XGA+ 1440 X 900 Resolution
XGA	eXtended Graphics Array

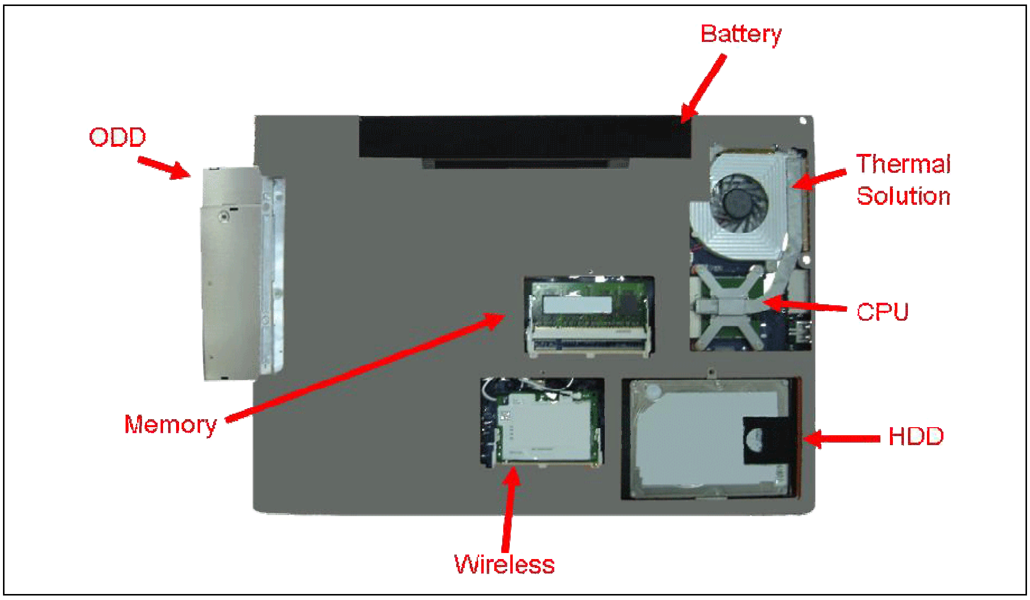
1.3 Related Documents

Document	Description
SFF-8201	2.5" drive form factor dimensions. http://www.sffcommittee.com/ie/Specifications.html
SFF-8223	2.5" drive w/Serial Attachment Connector. http://www.sffcommittee.com/ie/Specifications.html
SFF-8552	Form Factor of 5 1/4" 9.5 mm and 12.7 mm Height Optical Disk Drives. http://www.sffcommittee.com/ie/Specifications.html
SPWG 3.5	Standard Panels Working Group Specification. http://www.spwg.org
Various	Serial ATA specifications. http://www.serialata.org/specifications.asp
Various	Parallel ATA specifications. http://t13.org/
EIA-720	EIA Specification for Small Form Factor 63.5 mm (2.5 in.) Disk Drives

2 CBB Platform Ingredients Design Requirements and Recommendations

Laptop systems are designed in various configurations. While it is true that many components in a laptop system are integrated onto the motherboard, there are still several ingredients that need to be assembled. Designing a laptop BB for ease of assembly will make it easier for system integrators and distributors to deliver mobile solutions to the channel market. For instance, it may be a good design decision to place the microprocessor, memory, wireless card, and HDD in easily accessible locations in the laptop system for ease of assembly, service, and support. Figure 2 illustrates such an example. This section provides the system designer recommendations for designing a system using CBB ingredients.

Figure 2. Example of Barebone Laptop System with Ingredients Attached



2.1 Hard Disk Drive

There are currently two form factors for HDD used in laptop systems: 2.5-inch and 1.8-inch. In 2005, 2.5-inch HDDs account for approximately 95% of the total laptop market segment share compared to approximately 5% for 1.8-inch drives. Since 1.8-inch HDDs make up a relatively small percentage of the total laptop market, the CBB program currently includes only 2.5-inch HDDs and this design guide will not address the integration of 1.8-inch HDDs. This section describes the CBB design requirements of 2.5-inch HDDs into laptop systems.

2.1.1 Mechanical Requirements for HDD CBB

The laptop system should support 2.5-inch SATA or PATA HDDs that are designed based on the SFF specifications (SFF-8223/SFF-8201/EIA-720). The mechanical form factor for 2.5-inch HDDs is defined in SFF-8201 and applies to drives with either a SATA or PATA connector. The system designer interested in incorporating 2.5-inch HDDs should refer to SFF-8201 for form factor dimensions. Connector locations are provided in EIA-720 for PATA drives and SFF-8223 for SATA drives. The system designer will need to consult these documents to understand the details of connector location relative to the drive datum.

Although SFF-8201 defines HDD thicknesses ranging from 7 mm to 19.05 mm in discrete steps, the target CBB thickness for 2.5-inch HDDs in 2006 is 9.5 mm ± 0.2 mm, as this is the current predominant form factor. The surface across the top of the HDD may not be uniformly flat but no point should surpass the maximum specification of 9.7 mm.

There are two options for mounting the HDD, either bottom mounting or side mounting. A drive should comply with both options but the systems application may choose the one best suited to the design. See Section 3.2 for more information about HDD mounting holes.

The HDD drawings in Figure 3 and Figure 4 depict the critical mechanical dimensions from SFF-8223 and SFF-8201, respectively. Please refer to the latest version of the SFF specifications during the laptop design and integration process. These can be found on the SFF Committee website at http://www.sffcommittee.com/ie/.

Figure 3. 2.5-inch SATA HDD Critical-To-Function Dimensions Based on SFF-8223 Specification

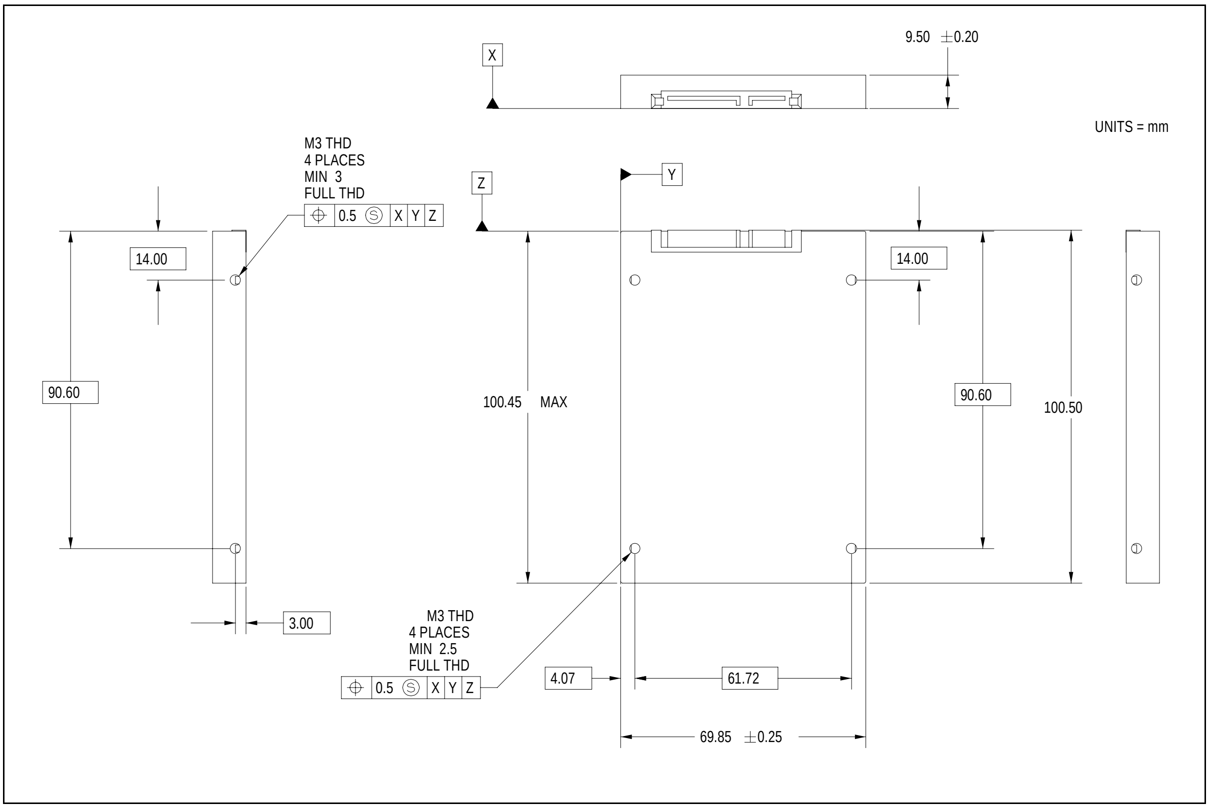
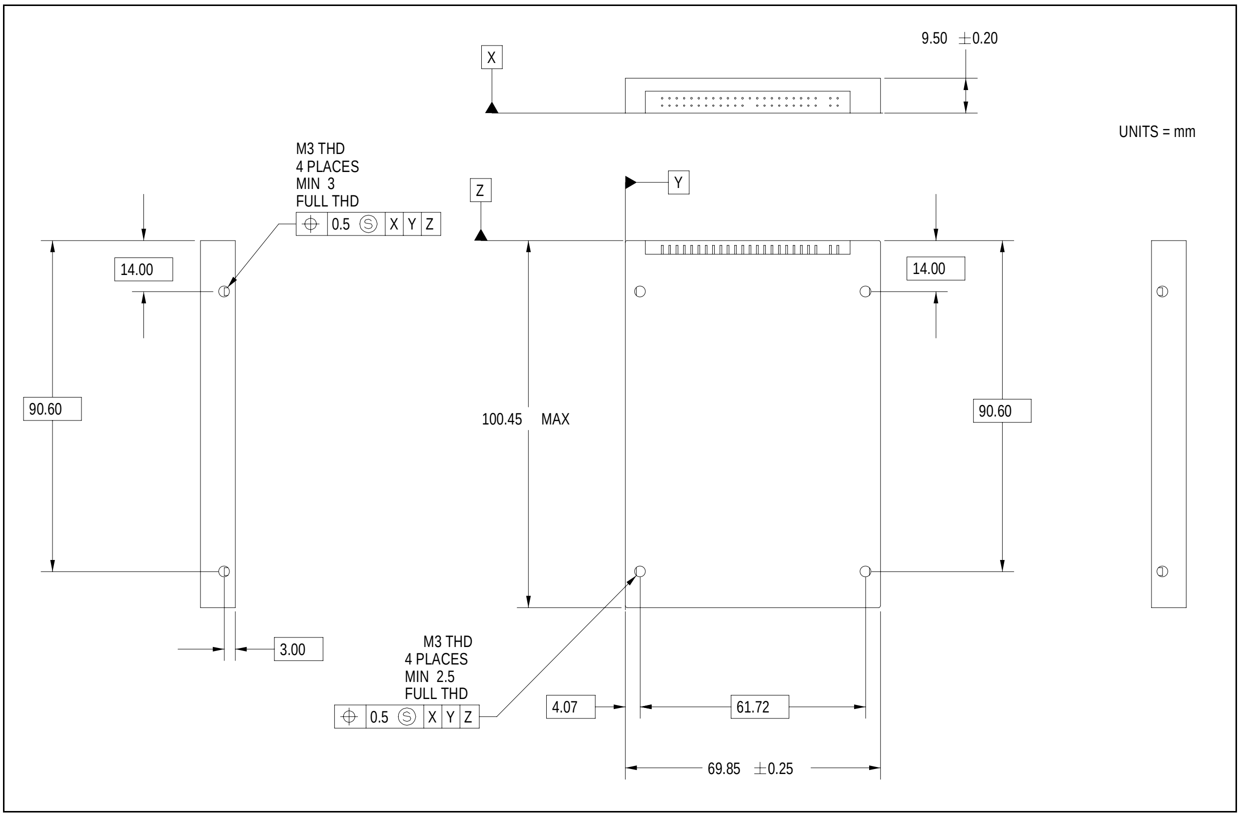


Figure 4. 2.5-inch PATA HDD Critical-To-Function Dimensions Based on SFF-8201 Specification



2.1.2 Electrical Requirements for HDD CBB

The electrical interface for SATA HDDs should follow the electrical interface specifications set by the Serial ATA International Organization (SATA-IO). These can be found in SATA II: Electrical Specification and can be accessed at http://www.sata-io.org/specifications.asp.

The electrical interface for PATA HDDs should support the specifications defined by the T13 Committee and published by ANSI (ATA/ATAPI). The specifications can be access at http://www.t13.org.

2.1.3 Engineering Trade-offs and Recommendations for HDD CBB

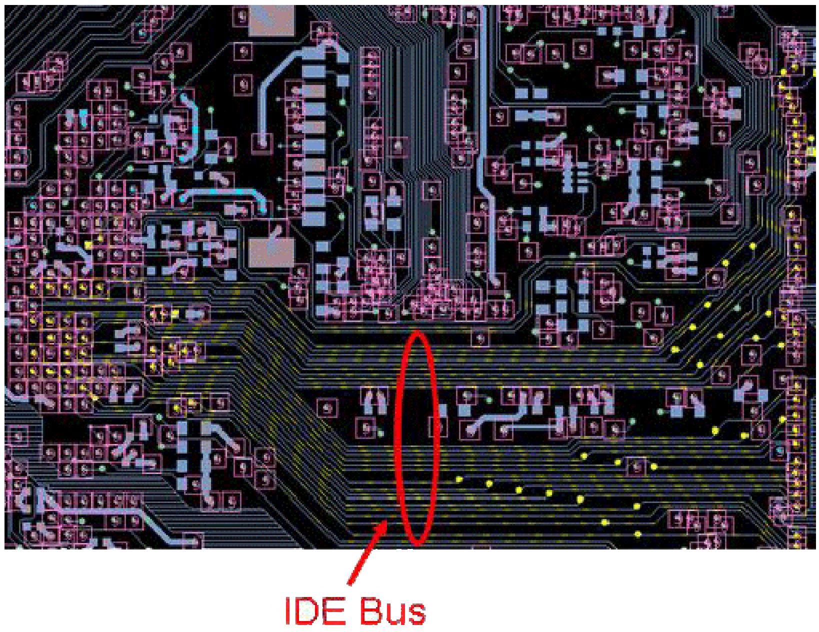
There are many options for the physical placement of the HDD in a laptop system. The HDD can either be placed alongside the ODD, opposite from the ODD, or they can be placed diagonally from each other. The electrical, thermal and mechanical, performance and power trade-offs will be discussed in the next three sub-sections.

2.1.3.1 Electrical and Layout Considerations

The use of a SATA HDD will result in a significant reduction of PCB layout footprint compared to that of a PATA HDD.

For PATA HDDs, 44 copper traces are required on the PCB (see Figure 5). Since the IDE signals are not critical high-speed signals, it is not necessary route these IDE signals in a high-speed PCB layer. If more than one PCB layer is needed to route all 44 traces, it is recommended that all data signals be routed together on the same layer and all control signals be routed on together on another layer.

Figure 5. HDD PATA Layout Routing Example



For SATA HDD, there are only 22 traces required (see Figure 6). The routing of differential signals (4 per data channel) need to be carefully considered and it is preferred to route these in a high-speed layer since the transfer rate is a minimum of 1.5 Gbps. The routing requirements for SATA data signals are stricter than PATA since they are differential pairs but there are much fewer data signals to route (4 data signals vs. 16 data signals).

Figure 6. HDD SATA Layout Routing Example

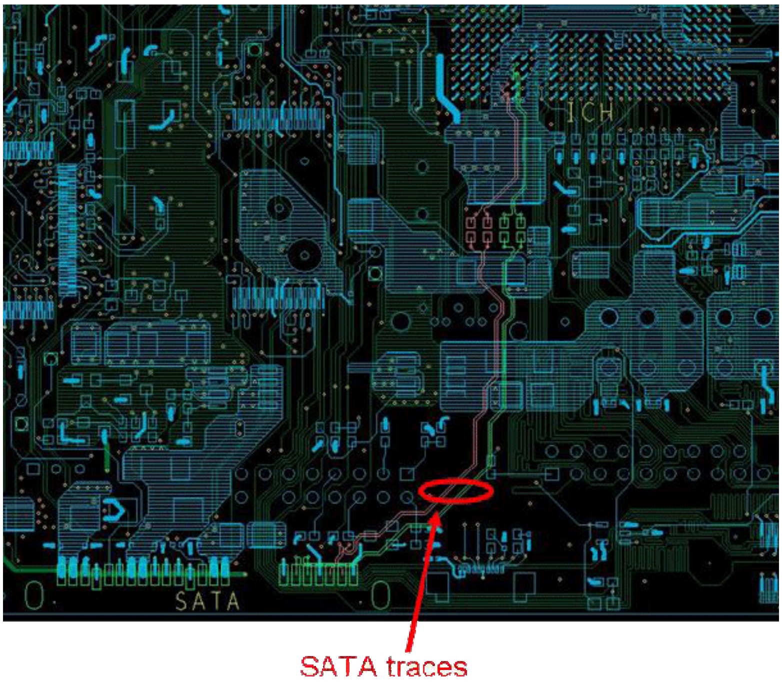
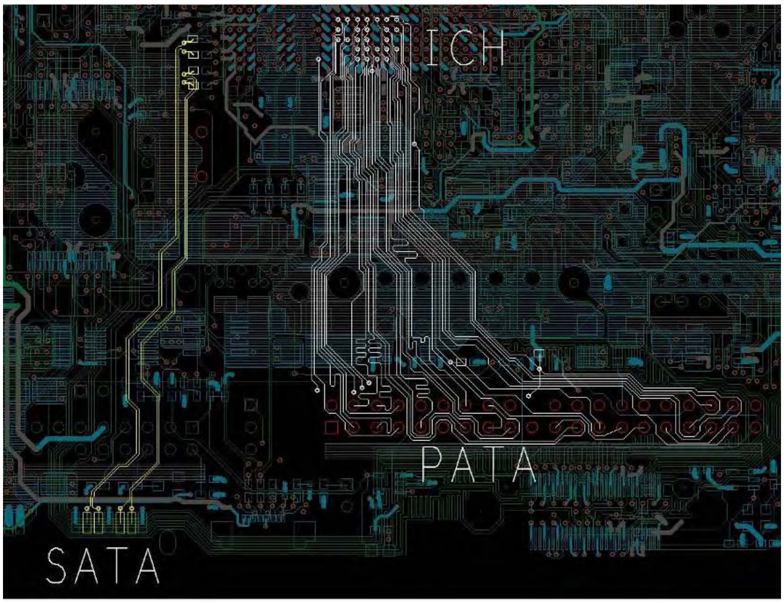


Figure 7 illustrates a real example in which both SATA and PATA traces were routed on the same motherboard.

Figure 7. SATA vs. PATA Layout on Same Motherboard

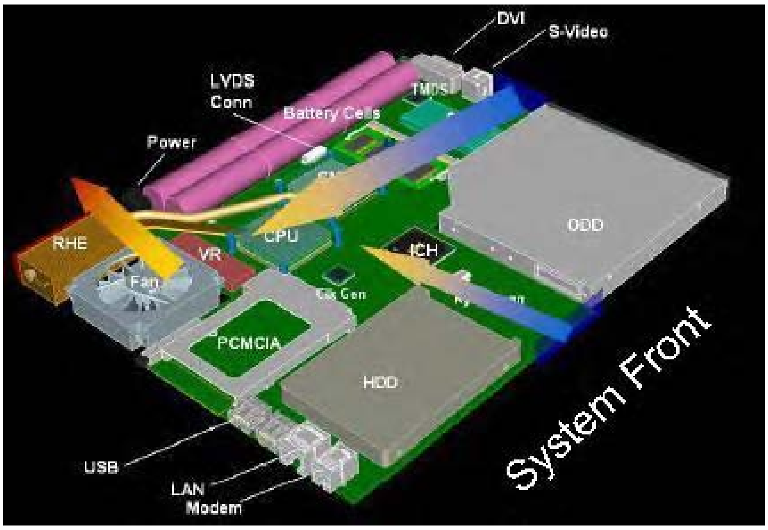


From an electrical design and layout perspective, it is recommended to use a SATA HDD over a PATA HDD based on the significant real-estate savings on the PCB. More details on SATA vs. PATA trade-offs for HDDs will be discussed in Section 2.1.3.3.

2.1.3.2 Thermal and Mechanical Considerations

HDDs can be placed in several locations in a laptop system. Based on the thermal, airflow, and ergonomic considerations in a laptop design, the processor thermal solution is often placed in the back of the laptop system, towards the LCD hinge side. It is ideal to divert the heat away from the user, such as directing the heat out the backside. If that is not possible, then it is best to direct the heat away from the user on either side towards the back.

Figure 8. Placement and Airflow Example

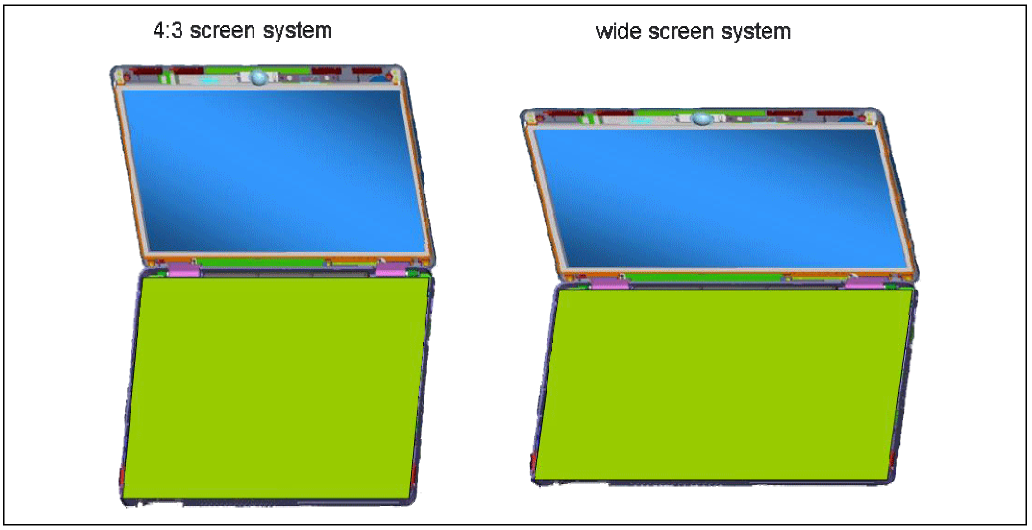


The HDD itself also dissipates heat since it is often spinning in a typical usage model. Figure 8 illustrates an example of a good HDD placement in a laptop system. In this layout example, airflow enters the system at the front and side of the motherboard. Most laptop systems do not have a dedicated thermal cooling solution for the HDD (or ODD). Therefore, it is important that the placement of the HDD does not block the incoming airflow into the system. Instead, the HDD should be placed such that the incoming airflow cools the HDD and excess heat is properly dissipated from the system.

Heat dissipation is an ergonomic issue. During intense usage models, the HDD platter may be spinning at full-speed for long periods of time. Care should be taken in the thermal design such that the HDD heat dissipation does not make either the top or bottom surface of the laptop system uncomfortable for the user. If too much heat dissipates to the keyboard topside surface (C-face) of the laptop, it may be uncomfortable for the user since that is where the user’s hands are either typing or resting. In addition, it is not ideal to have too much heat dissipation on the bottom surface (D-face) of the laptop system since it may be resting on the user’s lap.

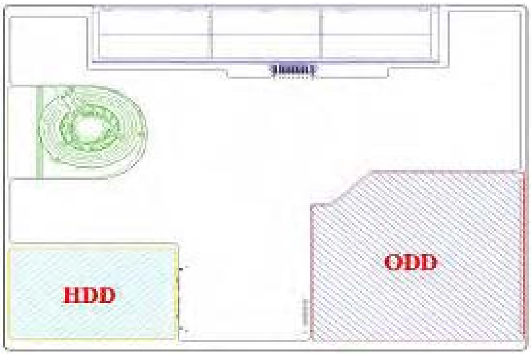
Besides thermal concerns, vibration is also a concern. If the HDD is placed under the palm rest area, care should be taken in designing the mounting of the drive such that the vibration generated by the palm movement will not be transmitted to the HDD and impact the reliability of the HDD or make it uncomfortable for the user. In addition, if the HDD is placed close to the ODD, care should be taken in designing the mounting of the HDD such that the vibration generated by the ODD will not be transmitted to the HDD and impact the reliability of the HDD.

Figure 9. Typical 4:3 Screen vs. Wide Screen Laptop System



For wide-screen systems such as 14.1W or 15.4W, the overall system motherboard and chassis is often wider but shorter in length. Figure 9 illustrates a side-by-side comparison of a traditional 4:3 aspect ratio and a typical wide screen system. For a wide screen system, the HDD and ODD are placed on opposite sides based on the shorter chassis length (see Figure 10). Once again, it is preferred to have the thermal solution placement near the back of the laptop system to satisfy the ergonomic design of the system.

Figure 10. Placement Example of HDD and ODD for Wide Screen Laptop System



2.1.3.3 Performance and Power Trade-offs

The design decision to use a SATA or PATA HDD will result in some performance and power trade-offs. Intel recommends that SATA HDDs be designed into laptop systems instead of PATA HDDs based on the performance and power-saving advantages that SATA HDDs offer over PATA HDDs.

SATA interface uses a point-to-point connection topology. Thus, each channel works independently such that there is no contention between multiples drives and no sharing of bandwidth. With SATA, there is also no need for master/slave settings on the HDD.

PATA can support up to two drives per channel via a shared bus. While the two devices are referred to as "master" and "slave", there is no difference in operation between or priority given to the devices. The IDE bus bandwidth is shared between the master and slave devices when both are actively interacting with the host. This results in performance degradation. For instance, the decision to incorporate a PATA HDD can result in performance degradation if the HDD is sharing the bus bandwidth in a master and slave configuration with a PATA ODD.

With a SATA implementation, there are fewer power and interface signals, resulting in a smaller connector, fewer pins, and more routing flexibility on the motherboard. SATA also provides a lower power solution by offering a lower voltage option (3.3 V) and enhanced device power management, when used with Intel mobile chipsets that support the Intel® Matrix Storage Technology (IMST). The IMST includes the Intel® Matrix Storage Manager (IMSM) driver that provides support for the SATA Advanced Host Controller Interface (AHCI). AHCI provides advanced performance for SATA drives through the implementation of Native Command Queuing (NCQ), a technology which enables the system and SATA HDD to optimally reorder multiple commands for efficient execution. Furthermore, the driver includes advanced power management through the implementation of Link Power Management (LPM), a technology which enables the system and SATA HDD to save power during idle states.

The Serial ATA International Organization website http://www.serialata.org/ offers documentation on SATA vs. PATA trade-offs, electrical design constraints, SATA specifications, and more.

There are many decisions and choices to consider in selecting the type of HDD (SATA vs. PATA) and the physical placement of the HDD in a laptop system. Based on the comparison detailed in Section 2.1.3, Intel recommends that a laptop system be designed to support SATA HDDs.

2.2 Optical Disk Drive

There are currently two laptop 5 ¼-inch ODD height form factors: 12.7 mm and 9.5 mm. In 2005, 12.7-mm ODDs account for approximately 90% of the total laptop market segment share compared to approximately 10% for 9.5-mm drives. The electrical interface is still predominantly PATA. The CBB program includes only 12.7-mm ODDs since that is the primary form factor used in laptop systems. This section describes the CBB design requirements of 5 ¼-inch, 12.7-mm height, tray-load PATA ODDs into laptop systems.

2.2.1 Mechanical Requirements for ODD CBB

For platforms launching in 2006, the laptop system should support 12.7-mm, PATA tray-load ODDs that are designed based on the SFF-8552 specification. The SFF-8552 specification includes the Generic Bezel Attach Specification (GBAS) for 12.7-mm height ODDs.

Intel recommends that the system designer select an ODD that is designed to GBAS. This is of particular importance for system designers or integrators who have common platforms but are targeting different SKUs and customer base. The use of ODDs that are compliant to the bezel attachment specification will allow innovation in laptop ID design.

The SFF-8552 specification defines the ODD z-height (thickness) as 12.7 mm ± 0.2 mm. The surface across the top of the ODD may not be uniformly flat but at no point should the height

exceed 12.9 mm. In addition, the SFF-8552 specification includes the maximum loads (pressure) on the top surface of the ODD that should not be exceeded.

The ODD drawings shown in Figure 11 and Figure 12 depict the critical mechanical dimensions from SFF-8552. Please refer to the latest version of the SFF specification from the SFF committee during the laptop design and integration process.

Figure 11. 5 ¼-inch, 12.7-mm Height ODD Critical-To-Function Dimensions Based on SFF-8552 Specification

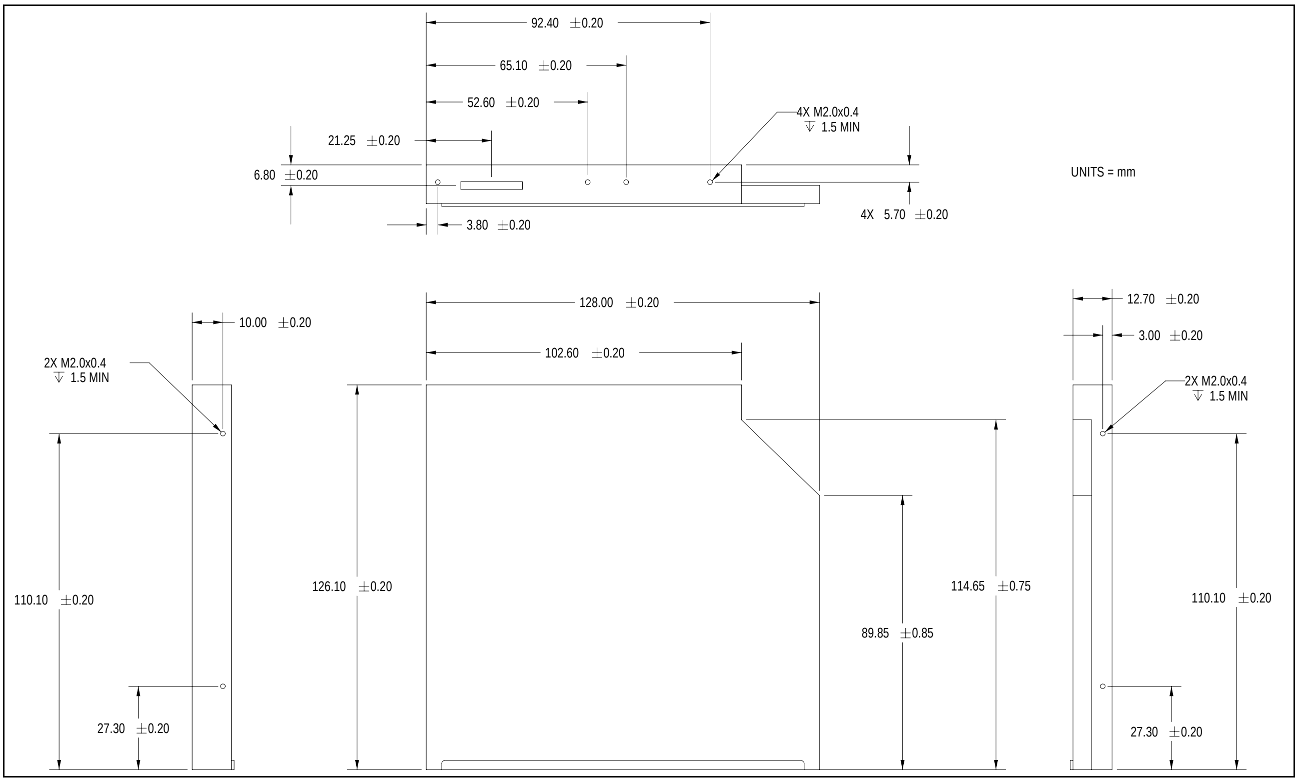
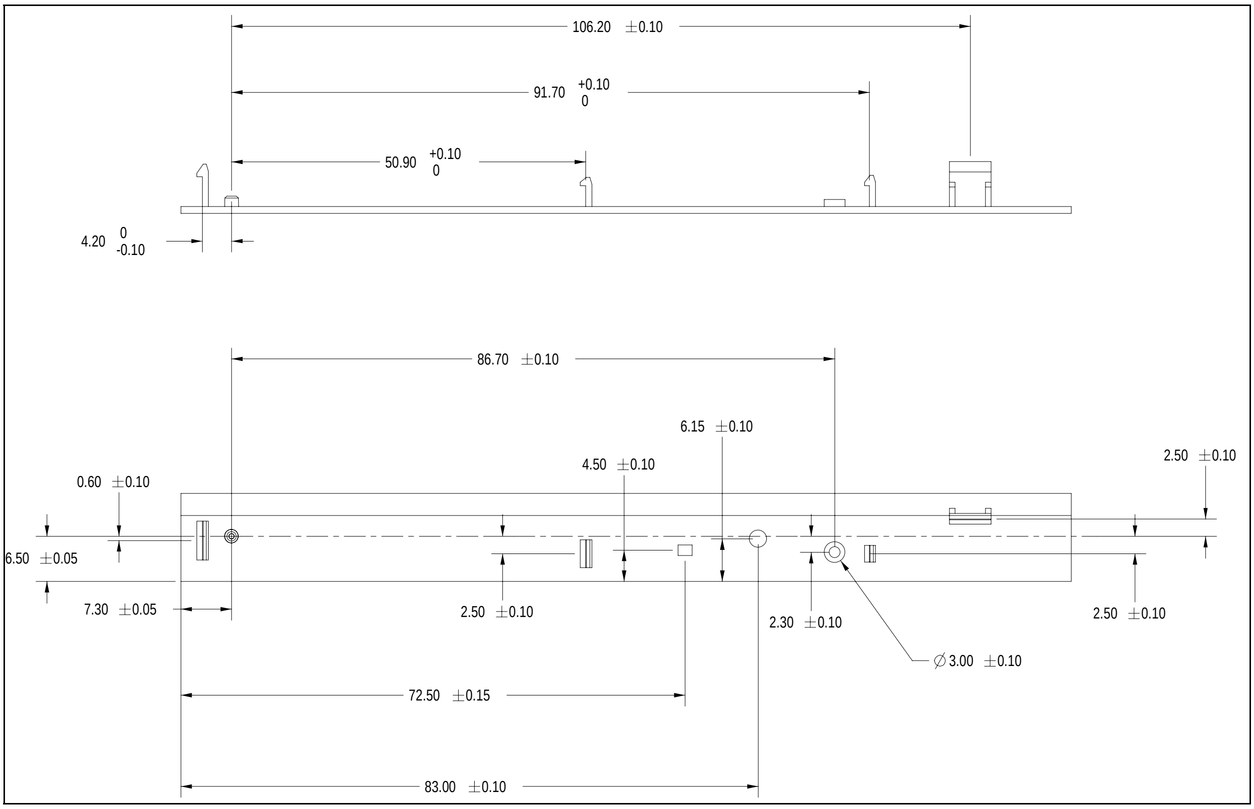


Figure 12. 5 ¼-inch, 12.7-mm Height ODD Critical-To-Function Bezel Attach Dimensions Based on SFF-8552 Specification



SFF-8552 describes the generic bezel attach for 5 ¼-inch, 12.7-mm height ODDs. System designers and ODD suppliers should follow this specification for the interface between the ODD tray (front surface) and the bezel (back plane). Particular attention should be paid to the four bezel snap locations, as well as the location for the bezel alignment pin, LED, eject button, and emergency eject tube. From a mechanical form and fit perspective, it is important that an OEM/ODM support different ODDs (either drive type or manufacturer) in their laptop system while preserving the same bezel ID.

2.2.2 Electrical Requirements for ODD CBB

Mobile PATA ODDs use a 50-pin connector with a 0.8-mm pitch. The electrical interface for PATA should support the specifications defined by the T13 Committee.

2.2.3 Engineering Trade-offs for ODD CBB

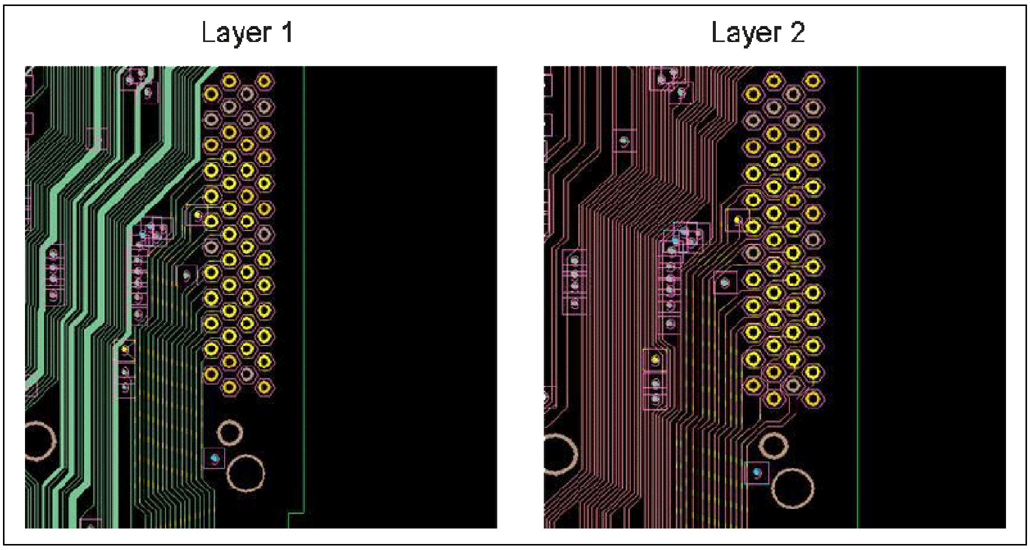
Similar to HDDs, there are many options in the physical placement of the ODD in a laptop system. The ODD can either be placed alongside the HDD, opposite from the HDD, or

diagonally. The electrical, thermal and mechanical, performance and power trade-offs will be discussed in the next three sub-sections.

2.2.3.1 Electrical and Layout Considerations

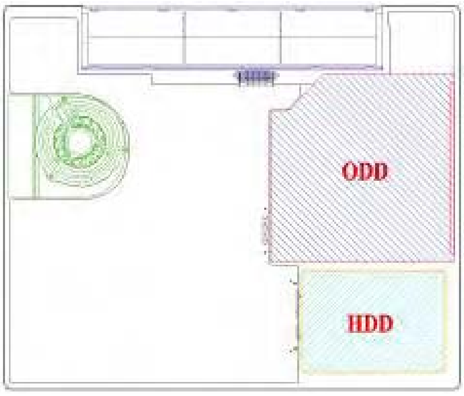
PATA ODDs require 44 traces on the PCB. Since the IDE signals are not critical high-speed signals, it is not necessary to route these IDE signals in a high-speed PCB layer. If more than one PCB layer is needed, Intel recommends that all data signals be routed together on the same layer and all control signals be routed together on another layer as shown in Figure 13.

Figure 13. ODD PATA Layout Routing Example



If both HDD and ODD are PATA devices, then it is preferred to place them alongside each other, as illustrated in Figure 14. This allows for closer proximity of both IDE devices for sharing the same IDE bus.

Figure 14. Close Proximity Placement of HDD and ODD



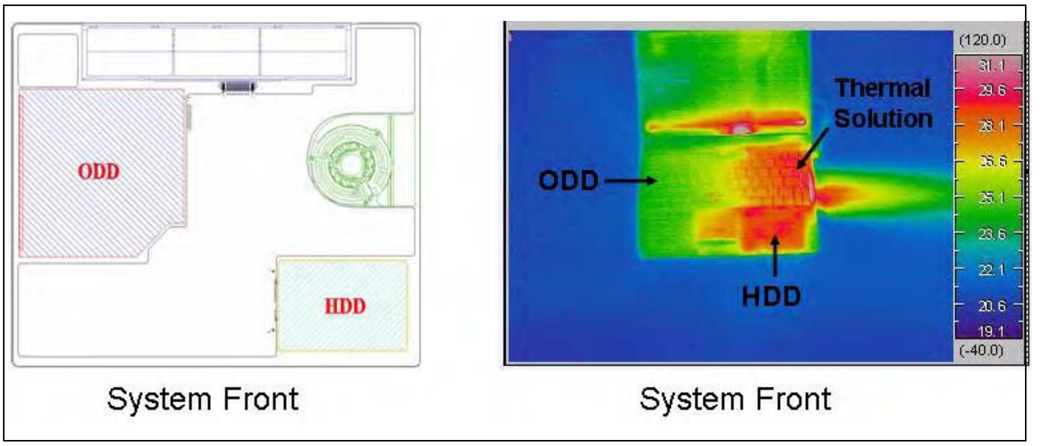
The example shown in Figure 14 works well in traditional 4:3 aspect ratio laptop systems. However, for widescreen systems, the ODD and HDD should be placed on separate sides of the

system since the overall system motherboard and chassis is often wider but shorter in length (see Figure 10).

2.2.3.2 Thermal and Mechanical Considerations

The thermal and mechanical considerations for an ODD are very similar to that of a HDD. Typical placement of the ODD allows for the drive to be opened from either side of the system or from the front of the laptop. Since many users are right handed, the ODD is often placed on the right side of the laptop system, which is an ergonomic benefit of proper system layout as shown in Figure 14. This provides the user easy access to the ODD.

Figure 15. Example of Non-ergonomic Placement of ODD and Thermal Solution



Additionally, it is not preferred to place the ODD such that the resulting thermal solution dissipates heat on the right side of the laptop. Many users may choose to use a separate mouse (i.e. USB mouse, wireless mouse) for ergonomic reasons; it is usually placed on the right side adjacent to the laptop system for right-handed users. Figure 15 illustrates the placement of ingredients in the platform and the resulting infrared thermal image during operation. The ODD is placed on the left side and thermal solution and heat exchanger are placed on the right side of the system. This is a non-ergonomic situation in which the heat is dissipated in the direction of the user's hand.

Based on the thermal and ergonomic considerations in a laptop design, it is recommended that the processor thermal solution be placed in the back of the laptop system, towards the LCD hinge side. It is ideal to direct the heat away from the user, which is directly out the backside. If that is not possible, then it is best to direct the heat away from the user on either side towards the back and avoid the scenario shown in Figure 15.

2.2.3.3 Performance and Power Trade-offs

The CBB program does not make any recommendations on the type, performance, or power of ODDs (CD-ROM, DVD-ROM, Combo, DVD+/-RW) as this is often based on end-user customers' needs and product differentiation and innovation among ODD suppliers.

2.3 LCD Panel

There are several laptop LCD panel sizes in the industry today. Some panels are custom designed while others are designed to industry specifications. This creates an uncertainty, limiting the choices of panels available for an ODM or system integrator designing or integrating a BB laptop. It also makes service and support difficult within the same panel size with mechanical discrepancies, differences in connector type, and incompatible interfaces being issues.

The CBB program currently encompasses LCD panel sizes of 14.1 inches(14.1S), 14.1 inches W (14.1W), 15.0 inches (15.0S), and 15.4 inches W (15.4W) with XGA and higher resolutions. The goal is ensure a common mechanical form and fit and basic electrical functionality for each panel size. This section describes the CBB design requirements for the referenced LCD panel sizes into laptop systems.

2.3.1 Mechanical Requirements for LCD CBB

The CBB program uses the SPWG 3.5 specification as a guideline. CBB compliance for LCDs generally matches SPWG 3.5, except as noted in the table below. Whereas industry specifications may target a broad base of panel sizes and resolutions, CBB LCDs consist of a more focused set of panel sizes and resolutions while still providing for major levels of product capacity. The areas where the LCD CBB requirements differ from SPWG specification are stated in Table 1.

Table 1. CBB Requirement vs. SPWG specification for LCD

Item	CBB Requirement
CCFL Cable Length	Must meet the minimum per the SPWG Version 3.5 specification, but may exceed the maximum by up to 50 mm.
Total Panel Thickness	Should be ≤ 6 mm for 14.1S and 15.0S panels. 15.4W panels should follow the SPWG spec for thickness at ≤ 6.5mm. 14.1W should follow SPWG spec for thickness at ≤ 5.5 mm.
15.4W Cable Offset	For 15.4W panels, the total of CCFL cable offset and CCFL cable length is equal to or exceed SPWG 3.5 minimum of 125mm. It is recommended that suppliers follow the specification stated in SPWG 3.5.

The LCD panel drawings shown in Figure 16 through Figure 19 depict the critical mechanical dimensions for CBB panels. Please refer to the latest version of the SPWG specification during the laptop design and integration process.

Figure 16. 14.1S LCD Panel Critical-To-Function Dimensions Based on SPWG 3.5 Specification

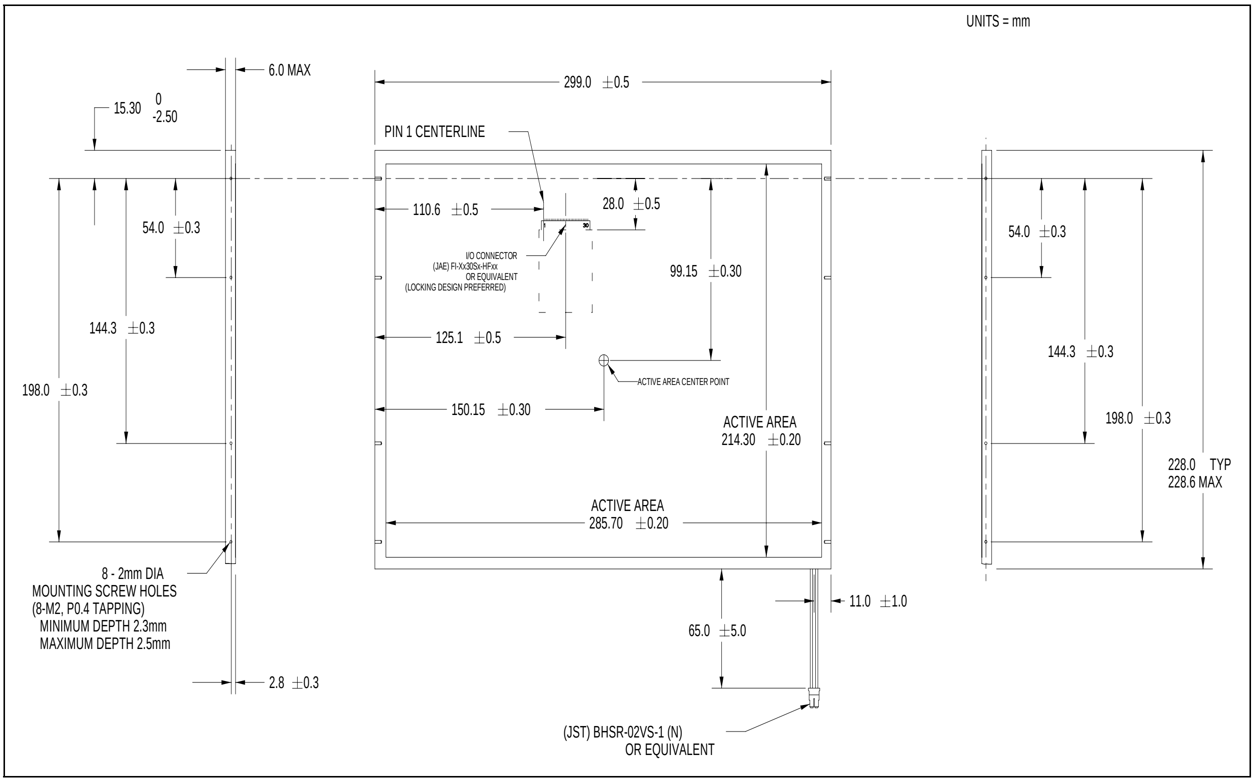


Figure 17. 14.1W LCD Panel Critical-To-Function Dimensions Based on SPWG 3.5 Specification

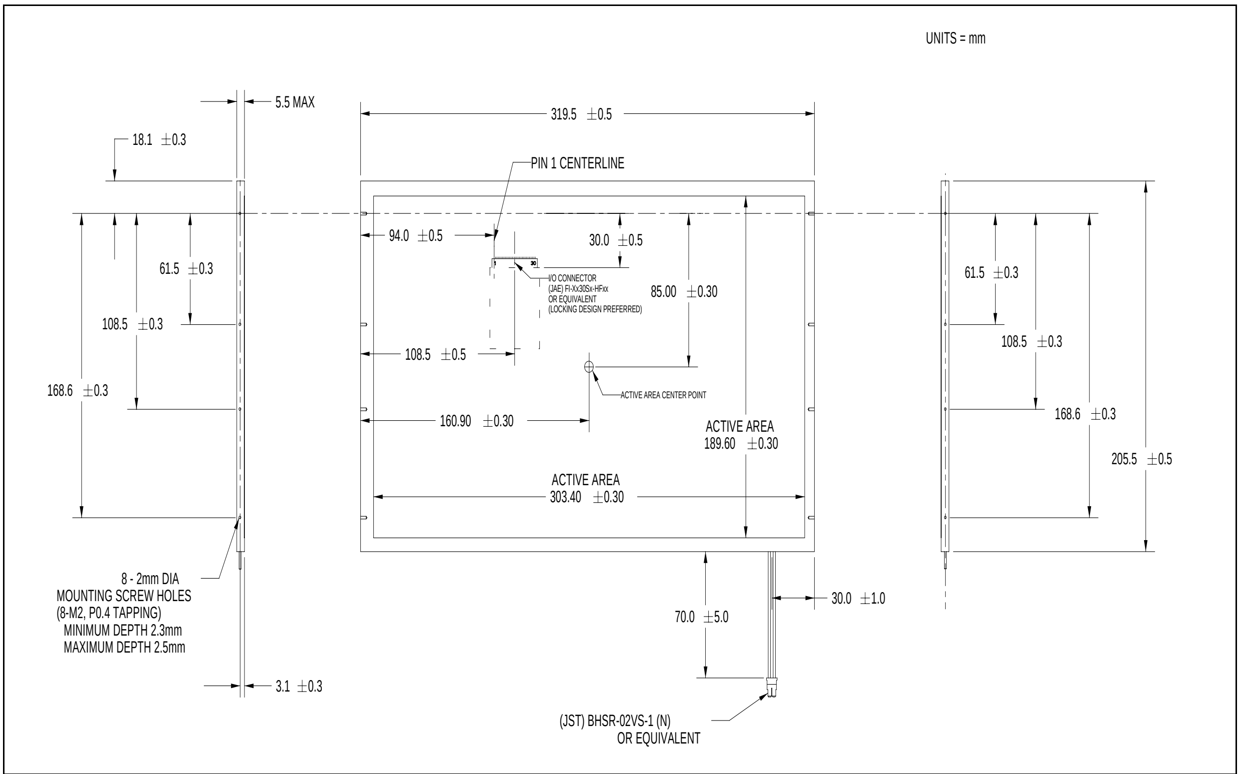


Figure 18. 15.0S LCD Panel Critical-To-Function Dimensions Based on SPWG 3.5 Specification

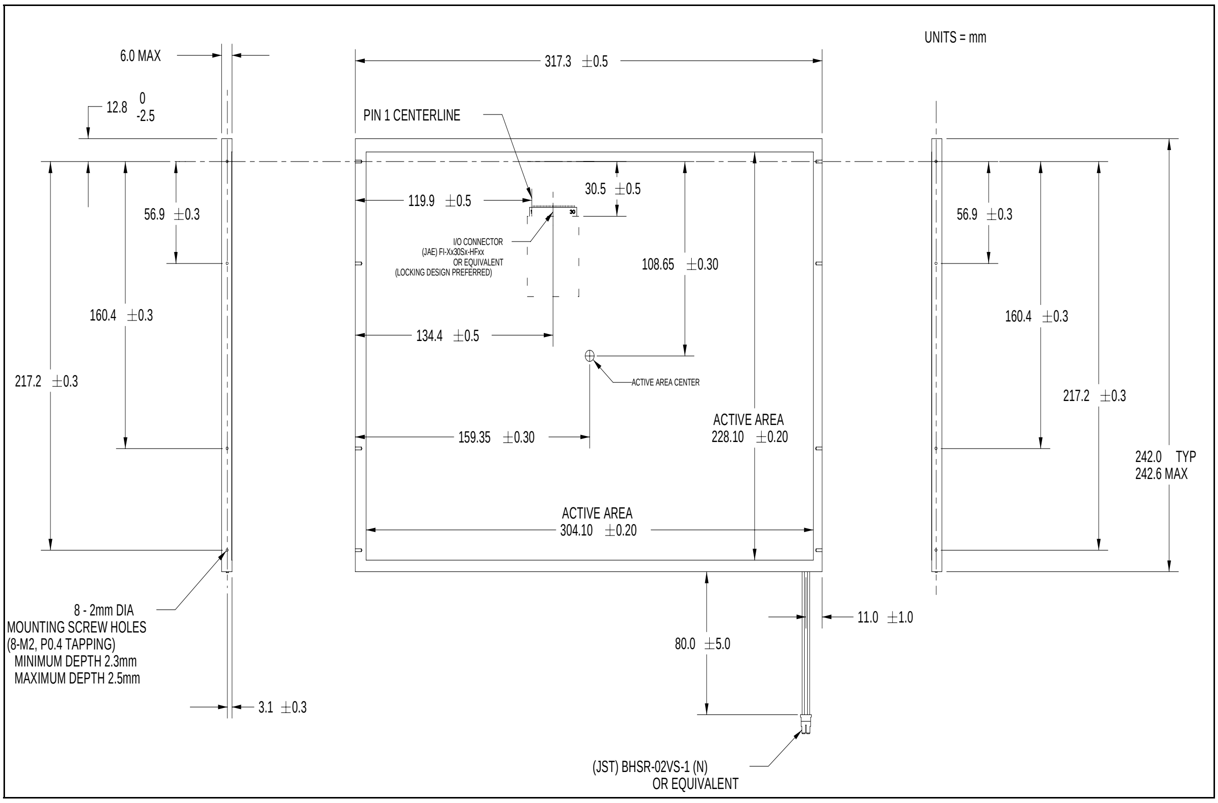
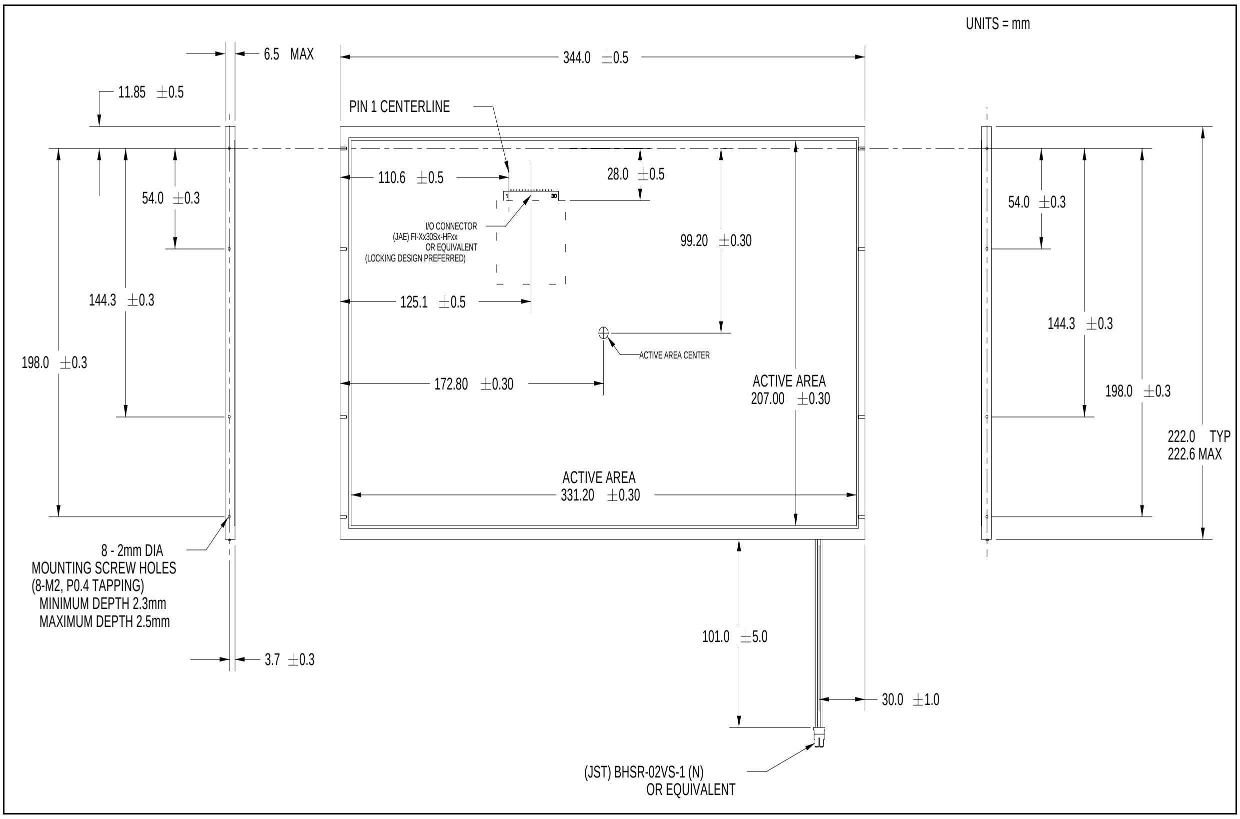


Figure 19. 15.4W LCD Panel Critical-To-Function Dimensions Based on SPWG 3.5 Specification



2.3.2 Electrical Requirements for LCD CBB

The panel resolution shall correspond to one of the resolutions for that particular size panel in Red Green Blue (RGB) pixel layout. Table 2 provides the CBB panel sizes and corresponding resolutions given in SPWG 3.5.

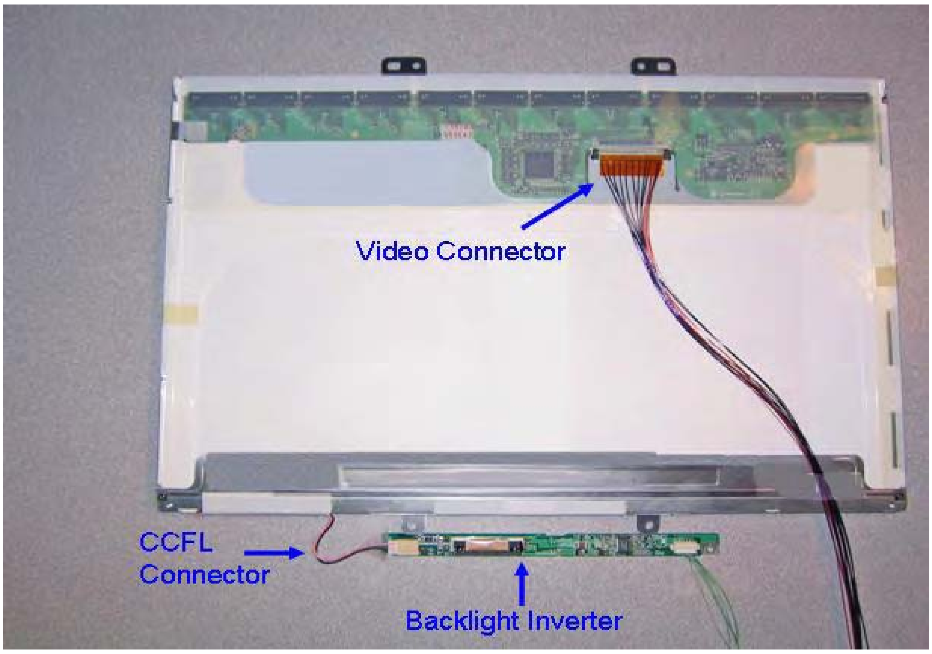
Table 2. LCD Panel Sizes

Panel Size	Resolution	Pixels	Aspect Ratio	Pixel Pitch	Pixels/Inch*
14.1S	XGA	1024 x 768	4:3	0.279	91
14.1S	SXGA+	1400 x 1050	4:3	0.204	125
14.1S	UXGA	1600 x 1200	4:3	0.179	142
14.1W	WXGA	1280 x 800	16:10	0.237	107
14.1W	WXGA+	1440 x 900	16:10	0.210	121
14.1W	WSXGA+	1680 x 1050	16:10	0.180	141
14.1W	WUXGA	1920 x 1200	16:10	0.158	161
15.0S	XGA	1024 x 768	4:3	0.296	86
15.0S	SXGA+	1400 x 1050	4:3	0.217	117
15.0S	UXGA	1600 x 1200	4:3	0.190	134
15.0S	QXGA	2048 x 1536	4:3	0.148	172
15.4W	WXGA	1280 x 800	16:10	0.259	98
15.4W	WXGA+	1440 x 900	16:10	0.230	110
15.4W	WSXGA+	1680 x 1050	16:10	0.197	129
15.4W	WUXGA	1920 x 1200	16:10	0.173	147

Signaling to the panel should be according to the LVDS specification at 3.3 volts. The LVDS connector on the panel must be a 30-pin I/O connector. Based on the panel sizes in the CBB program and SPWG specification, a 20-pin connector on the panel side is not allowed.

Besides the LVDS cable, a backlight inverter and CCFL cable are also needed for the LCD to function properly. This is shown in Figure 20.

Figure 20. LVDS, Backlight Inverter Connector Locations on LCD Panel



Laptop systems that want to support full panel interoperability must support Enhanced Display Identification Data (EDID). The objective is to allow the laptop system to read the EDID information from the panel and optimize the timing without requiring BIOS or driver changes whenever a new or different model panel is used.

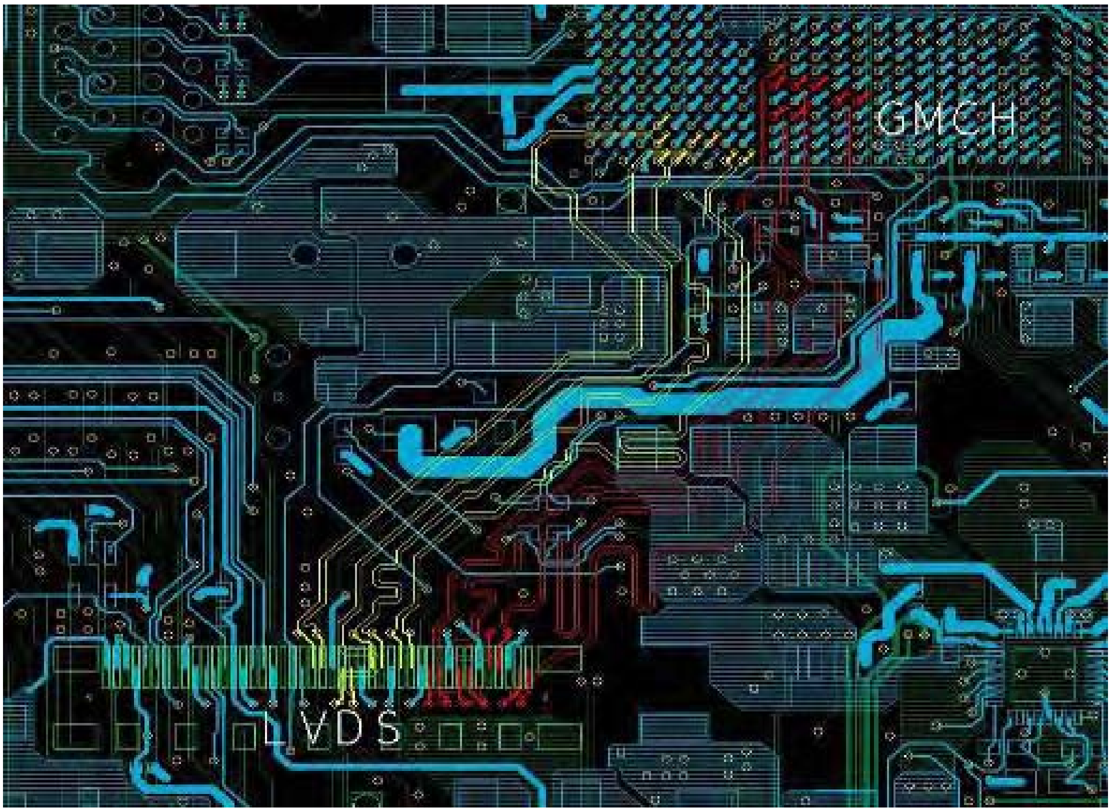
2.3.3 Engineering Trade-offs for LCD CBB

The LCD panel is placed inside the chassis lid of the system. The LVDS connector and CCFL connector on the LCD panel are well defined in SPWG specification. The design of the hinge and connectors on the board will affect the routing of LVDS and backlight inverter, along with wireless and other features such as a camera, secondary display on the top surface of the lid (A-face), etc.

2.3.3.1 Electrical and Layout Considerations

Figure 21 illustrates a real PCB layout routing of dual-channel LVDS. All designs must provide delivery of the full dual-channel LVDS signal set. Intel recommends that LVDS signals be routed in high-speed signal layers since differential signals are involved.

Figure 21. Dual-channel LVDS Layout Routing Example



2.3.3.2 Thermal and Mechanical Considerations

The LCD panel does not have any overall heat dissipation issues; however, the optical performance of the liquid crystal is impacted by temperature. Excessively low temperatures result in slow response and image smearing. High temperatures result in loss of contrast. The system designer should avoid collocation of other heat sources, such as WiFi transceivers, in the lid. LCD panel specifications generally range from 40msec response times down to 8msec. For uncontrolled hot environments, the fast response LCDs will generally be more susceptible to contrast loss. For very cold environments, the fast response LCDs may be a requirement, especially for end user video.

When the laptop system is designed to accept LCD panels that follow the SPWG specification, there should be no issues with mounting hole locations, length, width, and LVDS connector keep out regions. The one item that is open for consideration is LCD panel thickness. As mentioned in Section 2.3.1, the CBB requirements differ from the SPWG specification in defining the maximum thickness of panels. The trend of system designers is toward thinner and lighter panels in laptop systems. The design trade-off to consider is panel thickness versus availability.

Figure 22. LCD Panel, Chassis Considerations

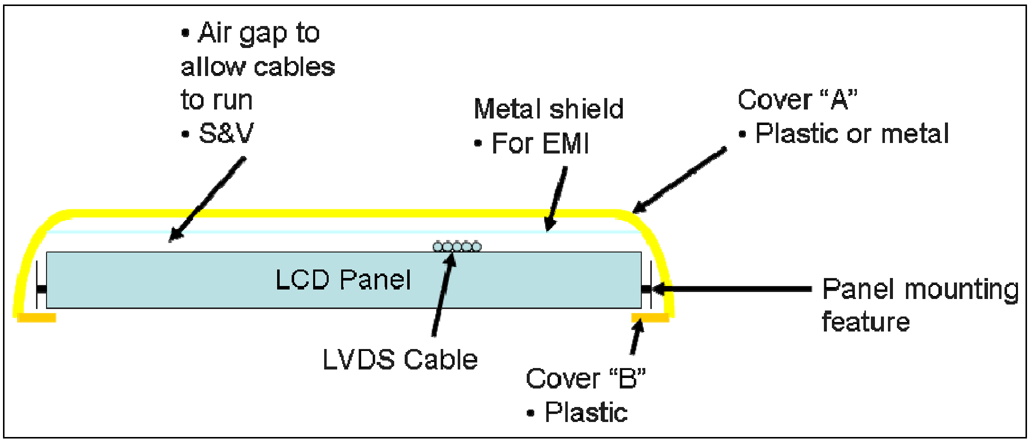


Figure 22 is an example of the LCD lid mechanical design in a laptop system. The design of the lid is often based on experience and empirical data from LCD panel stress testing and shock and vibration tests. The LCD lid frame must be designed to accommodate the maximum thickness of panels allowed in the CBB requirements for each panel size. The spacing in A-face side is used to route LVDS, wireless antenna, and other cables from the motherboard, through the hinge to the LCD lid. A panel that exceeds the maximum dimension called out in the CBB requirements should not be used.

2.3.3.3 Performance and Power Trade-offs

There are a number of optical parameters that vary among LCD panel designs that may affect system design and integration choices. Although these design parameters are not specified as part the CBB program requirements, some guidance is provided here.

These include the following:

- Viewing angle
- Color Saturation
- Screen Brightness
- Glare vs. Anti-Glare

Viewing angles vary among panel designs. Generally, with platforms intended for single-user viewing, narrower viewing angles are preferred. Wider viewing angle panels will consume more power and have shorter battery life for the same level of screen brightness. This is a trade-off that system designers and integrators should take into consideration.

Color saturation tends to be the same for most LCD panels. Generally, it is expressed as the percent of the NTSC color gamut the panel is capable of reproducing. Most panels available today are 45% NTSC. Some panels are as low as 40% while others are as high as 80%. A LCD generates color by filtering white light; therefore, incorporating a panel with high color saturation results in shorter battery life. Additionally, as plotted in Commission Internationale d'Eclairage (CIE) Lab and CIE Luv color space, dimmer images can be perceived as less saturated, reducing the effect of very high % NTSC levels.

Screen brightness is another differentiator among LCD panels. Brighter panels tend to be more optically efficient and offer longer battery life at reduced brightness levels. In addition, there are other recommended methods for increased screen brightness.

- Use an inverter matched to the panel. The lamps in different panels have different electrical requirements. Using an inverter that is matched to the panel saves energy and increases the maximum brightness of the panel.
- Use panels with thicker waveguides. A thicker waveguide can capture light more efficiently with a given lamp diameter. The cost of thicker waveguides is minimal. Lid frames should be designed to accommodate the maximum thicknesses allowed within the CBB specifications.
- Use a second collimating sheet. Though the collimating sheets have been expensive in the past, new vendors are bringing a more competitive environment to this component. A second collimating sheet can add as much as 40 nits to the maximum brightness of the panel.

Glare panels are more expensive than anti-glare versions as they require a higher quality LCD. Nonetheless, it offers improved Black Level and is much better for viewing video.

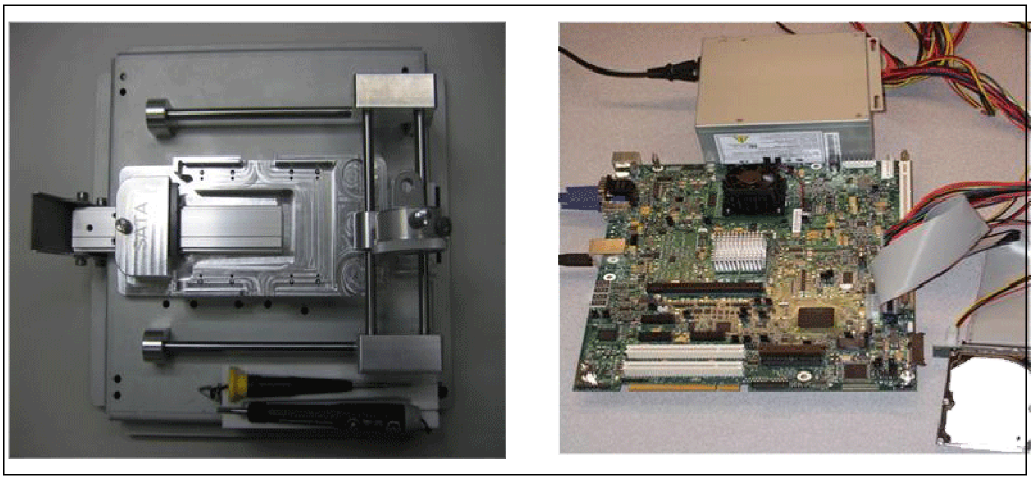
2.4 CBB Compliance Testing

As referenced earlier in Sections 2.1, 2.2, and 2.3, there are industry specifications available for each of the CBB ingredients. The SFF specifications cover the HDDs and ODDs while the SPWG specification applies to the LCD panels. Nonetheless, there is currently no common testing methodology done in the industry to ensure that these laptop ingredients are indeed being designed and manufactured to these industry specifications. Intel is currently working with the industry on defining and establishing a compliance testing process. Intel has begun CBB compliance testing on these ingredients, which includes mechanical form and fit and basic functionality tests for each ingredient.

2.4.1 HDD Compliance Testing

Figure 23 illustrates the equipment that is used for performing CBB compliance testing on HDDs.

Figure 23. CBB Compliance Testing Equipment for HDD



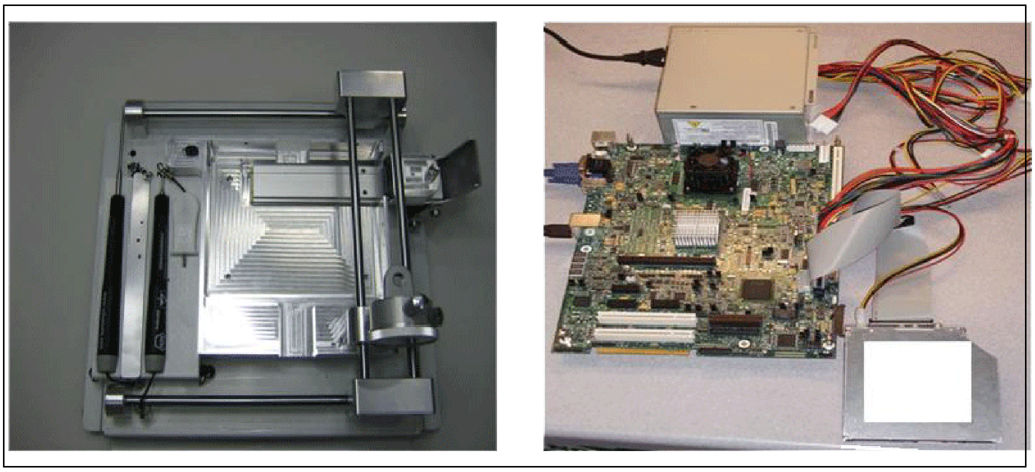
The HDD mechanical test gauge, shown in the photo on the left side of Figure 23, provides an efficient and repeatable method for checking the mechanical form and fit of a HDD. The critical dimensions checked include the HDD length, width, and thickness, side and bottom mounting hole locations, mounting hole screw depth, and PATA/SATA connector location and fit. If the HDD has been designed to comply with the SFF specification, then the designer can have confidence that it will fit in a chassis that has also incorporated the specification requirements.

Basic functionality testing is done on an Intel Mobile Customer Reference Board (CRB), which provides a common platform to test all HDDs (shown in the photo on the right side of Figure 23. The functional test consists of BIOS recognition of HDD and a power-on test to an operating system (OS). Functional testing is performed to verify the electrical connectivity and communication between the system and the HDD device. Performance and quality of the HDD are not assessed as these are viewed as product differentiation features and are left to the supplier.

2.4.2 ODD Compliance Testing

The SFF-8552 specification includes requirements for the mechanical form factor and Generic Bezel Attach Specification (GBAS) for 5 ¼-inch, 12.7-mm height ODDs. Figure 24 illustrates the equipment that is used for performing CBB compliance testing on ODDs.

Figure 24. CBB Compliance Testing Equipment for ODD



The ODD mechanical test gauge, shown in the photo on the left side of Figure 24, provides an efficient and repeatable method for checking the mechanical form and fit of an ODD. The critical dimensions checked include the ODD length, width, and thickness, side and rear mounting hole locations, mounting hole screw depth, connector location and fit, and bezel attach points and features. If the ODD has been designed to comply with the specification, then the designer can have confidence that it will fit in a chassis that has also incorporated the specification requirements.

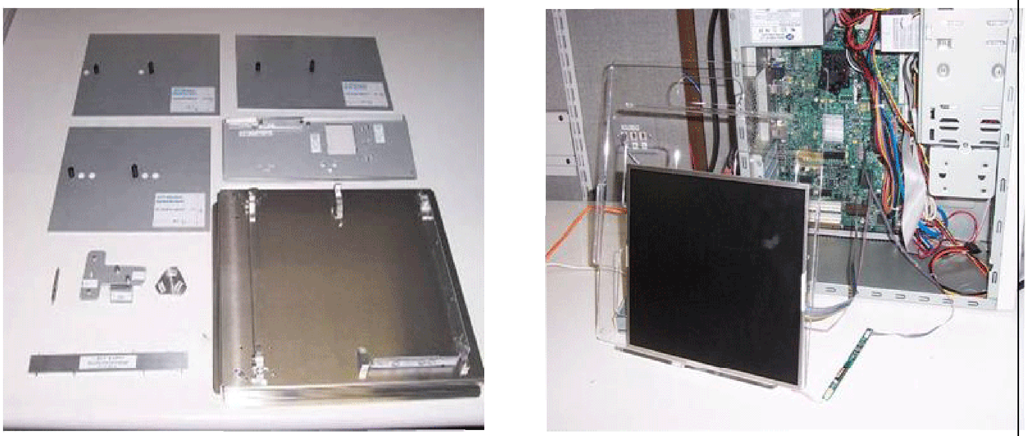
Basic functionality testing is done on an Intel mobile customer reference board (CRB), which provides a common platform to test all ODDs (shown in the photo on the right side of Figure 24). The functional test consists of BIOS recognition of the ODD, a power-on test to an OS, audio/video playback, file transfer capabilities, and media write capability for write-able drives. Functional testing is performed to verify electrical connectivity and communication between the

system and the ODD device. Performance and quality of the ODD are not assessed as these are viewed as product differentiation features and are left to the supplier.

2.4.3 LCD Compliance Testing

The LCD compliance testing for the CBB program is based on the SPWG specification with modifications, as documented in Section 2.3.1. Figure 25 illustrates the equipment that is used for performing CBB compliance testing on LCD panels.

Figure 25. CBB Compliance Testing Equipment for LCD



The LCD mechanical test gauge and tools, shown in the photo on the left side of Figure 25, provide an efficient and repeatable method for checking the mechanical form and fit of a LCD panel. The critical dimensions checked include the panel length and width, thickness, side mounting hole locations, mounting hole screw depth, active area, LVDS connector location, CCFL connector location, and CCFL cable length. If the LCD has been designed to comply with the specification, then the designer can have confidence that it will fit in a chassis that has also incorporated the specification requirements.

Basic functionality testing is done on an Intel mobile CRB, which provides a common platform to test all LCD panels (shown in the photo on the right side of Figure 25). The functional test consists of a power-on test and EDID reading of the panel's timing. Functionality testing is performed to verify electrical connectivity and communication between the system and the LCD device. Performance and quality of the LCD are not assessed as these are viewed as product differentiation features and are left to the supplier.

2.4.4 Result of CBB Compliance Testing

Results of CBB compliance testing on the three CBB ingredients (HDDs, ODDs, LCD panels) are shared with the suppliers in a confidential manner. The website http://www.mobileformfactors.org lists all CBB-candidate ingredients, which are posted by the suppliers. In addition, ODMs are able to list any platforms that are designed to accommodate CBB ingredients. Those ingredients that have been submitted by the supplier for testing and have met the compliance testing criteria will have a checkmark on the website.

For the CBB ingredients that do not meet the compliance testing criteria, Intel will share the specifics of the test results with that ingredient's supplier and work with them to address the issue.

The website http://www.mobileformfactors.org is the location for the latest information regarding CBBs with links to industry specifications, lists of CBB-candidate ingredients and CBB compliant ingredients, as well as links to system designers and ingredient suppliers.

3 CBB Platform Ingredients Integration

This section is intended for laptop system integrators and distributors. It describes the advantages of selecting a laptop platform designed with CBBs in mind. It also provides recommendations on system level integration of the current ingredients in the CBB program.

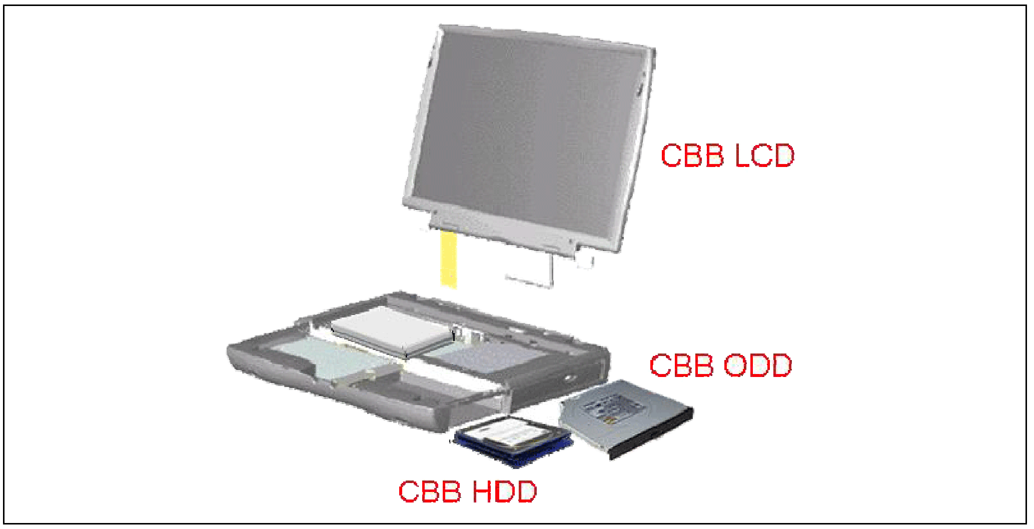
3.1 Advantages of Selecting A Platform Designed to Accommodate CBB Ingredients

There are several benefits that the CBB program offers for system integrators and laptop distributors. As these ingredients are being designed and manufactured to comply with industry specifications, there will be an increased supply resulting in more choices. With the rapid growth of the mobile market, the CBB program will offer new levels of serviceability and support. Selecting CBB ingredients and choosing to use platforms designed to accommodate CBB ingredients will reduce the risks associated with incompatibility during system integration. The website http://www.mobileformfactors.org provides information about CBB program and lists CBB-candidate ingredients and CBB compliant ingredients.

3.2 System Integration Recommendations

This section is intended for system integrators who are interested in using CBB ingredients in their laptop systems. Recommendations will be provided regarding integration of HDDs, ODDs, and LCDs across laptop systems (see Figure 26) that are designed to accommodate CBB ingredients.

Figure 26. CBB Ingredients in Laptop System



3.2.1 HDD Recommendations

HDDs are highly sensitive to impact and/or vibration. Since the HDD is commonly used as the boot device for the system, it is important to consider mounting schemes when integrating 2.5-inch form factor HDDs into laptop systems. Proper mounting of the HDD will help to stabilize the drive during shock and/or vibration events.

Laptop HDDs in the 2.5-inch form factor are designed with a total of eight mounting holes that accept screws. The eight mounting holes can be divided into two sets: The first set includes four mounting holes located on the bottom surface of the drive and the second set includes four mounting holes that are located on two side surfaces. While the actual selection and use of the mounting holes are left to the system designer or system integrator, it is recommended that all four mounting holes in either set be used to ensure proper reduction of shock and vibration during transportation of the system.

Mounting schemes for HDDs are also important when performing upgrades or replacements of HDDs. The first step is always to power off the system. Once powered off, the HDD can be removed from the system by removal of the mounting screws. This may require opening a portion of the external skin of the chassis. Be aware that some systems incorporate additional mounting schemes that can include mounting trays and/or insulating material.

Before replacing the existing HDD device, the system integrator should ensure that the replacement HDD has the same connector type (SATA or PATA) as the original HDD. A system designed using a SATA HDD can only accept a replacement SATA device. Similarly, if the original HDD device is a PATA device, the replacement device must also have a PATA connector. Finally, HDDs allow for both cable-select, as well as non cable-select formats. It is important to select the correct format for the system when upgrading or replacing the original HDD. If the wrong format is chosen, the system may not recognize the HDD or the HDD may not function correctly in the system.

Figure 27 through Figure 30 illustrate an example of a set of procedures for replacing (and integrating) a HDD from the system. This procedure is short and easy to perform.

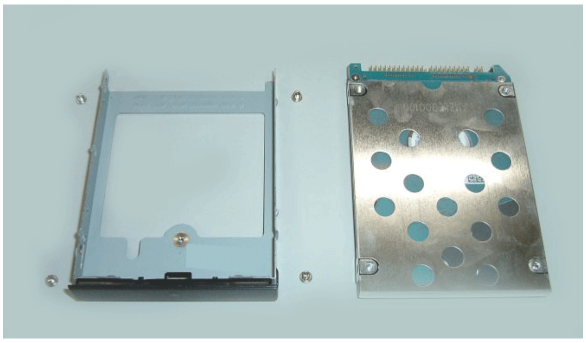
Caution: It is important to ensure the person performing this task is grounded and the laptop system is protected from electrostatic discharge (ESD).

Figure 27. Remove the System Mounting Screws from HDD Module

Figure 28. Remove the HDD Module from the Laptop HDD Slot

Figure 29. Remove the HDD from the HDD-Chassis/Bracket

Figure 30. HDD, HDD-Chassis/Bracket, Mounting Hole Screws



Once the new HDD is installed, it must be configured to work in the system. The system integrator should have a hardware image (i.e., Ghost Image) available that includes the drivers and software applications for their laptop systems. This is often bundled in a CD; thus, the BIOS should be configured to have the ODD ahead of the HDD in the boot sequence. The system may require a re-start after loading the hardware image onto the newly installed HDD. The basic functionality of the HDD is achieved when the laptop system has successfully booted to the operating system.

3.2.2 ODD Recommendations

ODDs utilize both side and rear mounting holes. In total, there are eight mounting holes on each ODD (two each on the right and left sides and four on the back).

Some system designers may choose to use swap-bay mounting to allow for 'hot-swapping' or 'warm-swapping' capabilities. These capabilities allow removal of the ODD while the system is running, rather than completely shutting the system down and removing the ODD while the system is without power. SFF-8552 does not provide details on swap-bay mounting, nor is this included in the CBB program currently. Typically, however, the rear and sometimes side mounting holes of the ODD are used for the swap-bay mechanism.

For upgrade or replacement of fixed-mount ODDs, the system must be completely powered off. Once powered off, the ODD can be removed from the system by removal of the mounting screws. This may require opening of the system chassis or a portion of the chassis first, as the ODD may be internally mounted in the system, rather than mounted at the external skin of the chassis.

Figure 31 through Figure 33 illustrate the procedures for replacing (and integrating) an ODD in the system. Similar to the HDD, this procedure is short and easy to perform.

Caution: Ensure the person performing this task is grounded and the laptop system is protected from ESD.

Figure 31. Remove the System Mounting Screws; Remove the ODD from ODD Slot

Figure 32. ODD with Bezel Attached

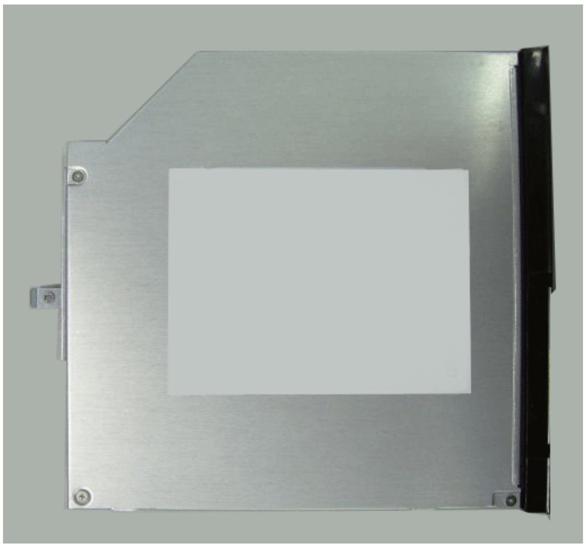


Figure 33. ODD Bezel after Removal from ODD

When replacing or upgrading the original ODD from the system, the bezel should be transferred from the original ODD to the replacement ODD to maintain a consistent look and feel of the system. Bezels are typically plastic in material; care should be taken in the removal process of the bezel from the original ODD. SFF-8552 defines the alignment pin, as well as four snap features to affix the bezel to the ODD. It is important to use an ODD that is CBB compliant to ensure that the bezel from the original drive will fit onto the new drive.

ODDs allow for both cable-select, as well as non cable-select formats. It is important to select the correct format for the system when upgrading or replacing the original ODD. If the wrong format is chosen, the system may not recognize the ODD or the ODD may not function correctly in the system.

Once the new ODD is installed, the system should be powered-up to the OS and checked that the OS does indeed detect the ODD. The ODD supplier should supply drivers for their ODD. Some basic functionality tests to be performed include video/audio playback and file transfers.

3.2.3 LCD Recommendations

LCD panels utilize eight total mounting holes, four on each side. All eight mounting holes should be used to ensure proper reduction of shock and vibration during transportation of the system.

For replacement of LCD panels, the system must be completely powered off. Once the system is powered off, the panel can be removed from the system by disconnecting both the LVDS and CCFL cable. This will require opening the system panel lid and LCD bezel on the inner panel surface (B-face), and sometimes a portion of the chassis to remove the panel hinge.

There are different types of implementation for the lid in a laptop system. Figure 34 through Figure 37 illustrate an example of a set of procedures for replacing an LCD panel in the system. While this procedure requires a few more steps and more care than replacing the HDD or ODD, it is not a difficult task.

Caution: Ensure the person performing this task is grounded and the laptop system is protected from electrostatic discharge (ESD).

Figure 34. Components in a Laptop LCD Lid and their Stack Up

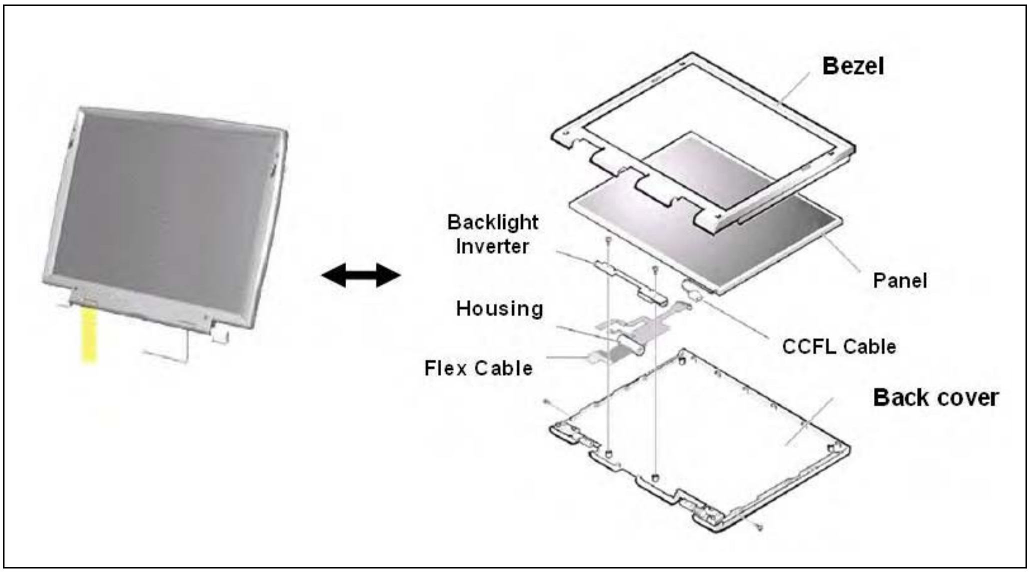


Figure 35. Remove the B-face Mounting Screws on the LCD Bezel

Figure 36. Remove the LCD Bezel and Side Mounting Hole Screws

Figure 37. Disconnect the LVDS and CCFL Connector; Remove the Panel

The same LCD bezel and panel lid should be transferred from the original to new LCD panel to maintain a consistent look and feel of the system. Once the new LCD panel is installed, the system should perform a power-up test. The panel should be lit and display the system startup images correctly during system power-up. This ensures that the electrical connections to both the CCFL and LVDS cables are functioning electrically. It is recommended that the system have an EDID-enabled BIOS, so that the EDID values can be detected by the platform to ensure that the correct panel characteristics (timing information) is communicated between the system and LCD panel. An EDID utility tool is available for download from http://www.spwg.org.

The CBB requirements only list the maximum panel thickness for each panel size. Thus, different panels of the same form factor may have different thickness. If the laptop system was designed to accommodate the maximum panel thickness for a particular panel size, then that system should be able to accommodate any panel of that size that is designed to CBB requirements. Therefore, special attention should be paid to the panel thickness to ensure that the platform can accommodate the new LCD panel's thickness. Using LCD panels that are thicker than what is allowed in the CBB requirements or what the laptop system can accommodate may result in integration and quality issues.

LCD panels that are designed to CBB requirements should have the proper location and keep-out region for the LVDS connector. In addition, the CCFL cable length should meet the minimum requirements of the SPWG specifications. If the CCFL cable is too short, it will not be able to connect to the backlight inverter, resulting in the panel not being lit.

4 Summary

The CBB program benefits include an increased ingredient supply base and ease of integration, as well as system differentiation and innovation. Suppliers can focus on ingredient innovation and brand differentiation based on performance, acoustics, power, or other value added features. This, in turn will allow system designers and integrators to focus on their own platform or brand differentiation.

All CBB ingredients that have the CBB compliant checkmark on www.mobileformfactors.org have met the minimum requirements for CBB compliance for mechanical fit and form as well as basic electrical functionality. Intel does not test the performance, quality, and reliability of CBB ingredients nor does Intel recommend any particular supplier or ingredient over another. It is the responsibility of the system designers and system integrators to ensure each ingredient functions correctly in the particular system.